IXO
Mission Overview

D Lumb and J Bookbinder

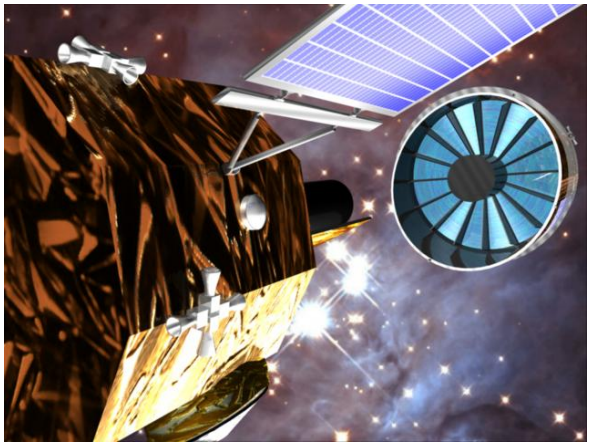
Paris, Science Workshop

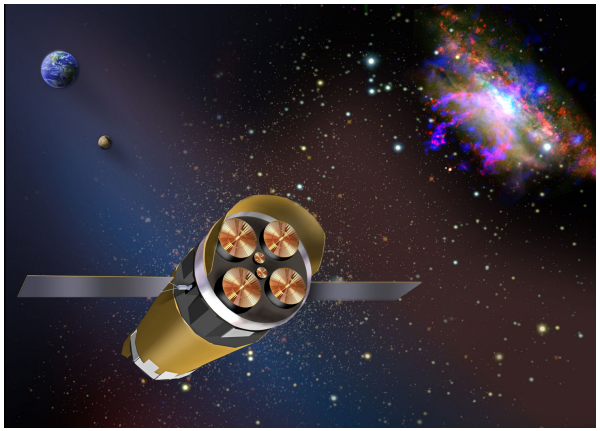
27/4/2010

Introduction

- **We are here to update the community about the current status of the IXO studies**
- **Need to be sure that the science case is consolidated for submission to the Cosmic Visions assessment *Yellow Book***
- **Reinforce the message that the community has to lobby hard to support IXO into the next phase**
- ***Technical presentations to demonstrate IXO is technically feasible and supports a huge range of science investigations***
- ***Science talks addressing many areas of interest – we will try to ensure that a broad and coherent case is constructed from all the inputs (let's have your images and simulations)***
- ***Strengthen the links within the community (~200 people here but 2000 people use data from the Chandra and XMM observatories)***

Mission History





The well recognized science case for a large-area X-ray Observatory led to:

- **Con-X: NASA concept, number two large mission after JWST in 2000 Decadal survey**
- **XEUS: ESA with JAXA candidate as large Cosmic Vision mission**

Similar science goals, but different implementations

Merger of XEUS and Con-X in 2008

- **Formation of Study Coordination Group (SCG) and advisory groups – co-chairs by 3 agencies: SDT, IWG, TWG**

Await prioritization by Astro2010 Committee & ESA Cosmic Visions L-Class mission down selection

The study progress

- NASA conducted a detailed study via its Integrated Mission Design process
  - has requested follow-up support from industries
  - Supporting instrument teams and mirror technology

- ESA Industrial contracts - Mission "Pre-Phase A" Studies
  - Kicked off studies with Thales and Astrium in Summer 2009
  - Mission Definition Reviews held at end 2009
  - Mission Final Reviews/Reports planned for July 2010

- ESA Instrument "Pre-Phase A" Studies
  - Kicked off instrument studies in June 2009
  - Instrument Definition Reviews held in December 2009
  - Instrument Mid-term Reviews in March - April 2010
  - Plan Instrument Final Reviews/Reports for July 2010
- SEE FOLLOWING TALKS

Cosmic Visions

- **SUMMARY BY F FAVATA ON THURSDAY**
- **M class missions down selection – Solar Orbiter, Plato, Euclid (and SPICA) -** ***what can we learn***
- **The fall out of this may require a difficult balance for funding and maintaining a broad range of disciplines in the ESA Science Programme**
- **Next step is a competition between LISA (a "big idea" mission), Laplace ("let's go and explore") and IXO (wide ranging science).**
- **We need to get beyond the next selection milestone, for example contrast the IXO strong gravity/ accreting black holes vs. LISA**
- **Also a competition to show what is technically feasible and affordable on the timescale (ESA CaC 650 Meuro for L class – keep IXO as affordable as possible / descope back stop / don't push all science requirements)**
- **We must ensure the science case for IXO is broad, but demonstrate some paramount unifying themes**
- **E.g. from the Cosmic Visions Themes**
  - **(Q4.3) The Evolving Violent Universe**
  - **(Q4.2) The Universe taking shape**
  - **(Q3.3) Matter Under Extreme Conditions**

- and Astronet

- Other CV themes such as Q4.1 "Early Universe"
- Astronet Science Vision exercise defines the science goals of European astronomy for the next two decades
- **IXO features prominently in the Astronet roadmap & will provide responses to a very large fraction of the questions posed**
- IXO therefore strongly placed as one of the most important facilities to impact on the science objectives of Astronet & Cosmic Visions

Personnel

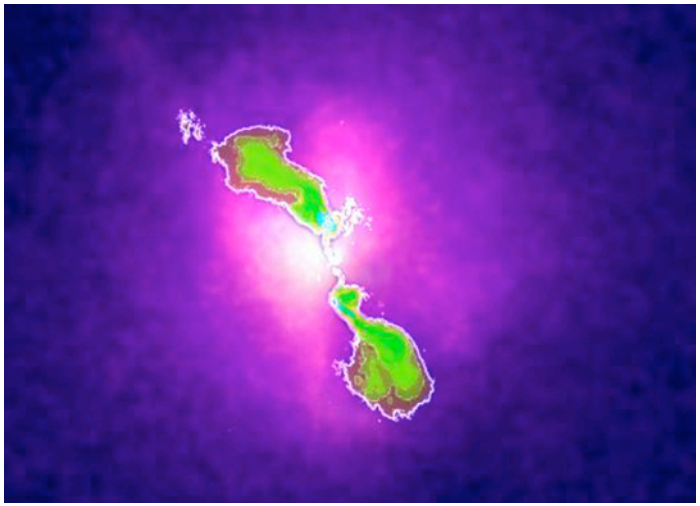
- **Agency study teams. the coordination group, community advisory groups for science and payload as well as industry are all well-represented at this meeting**

	ESA	NASA	JAXA
Study Manager	N Rando	J Grady	T Dotani
Study Scientist	D Lumb	N White	H Kunieda
Community Scientists	K Nandra L Piro D Barret L Strüder	J Bookbinder K Flanagan J Bregman M Bautz	K Mitsuda T Ohashi T Tsuru

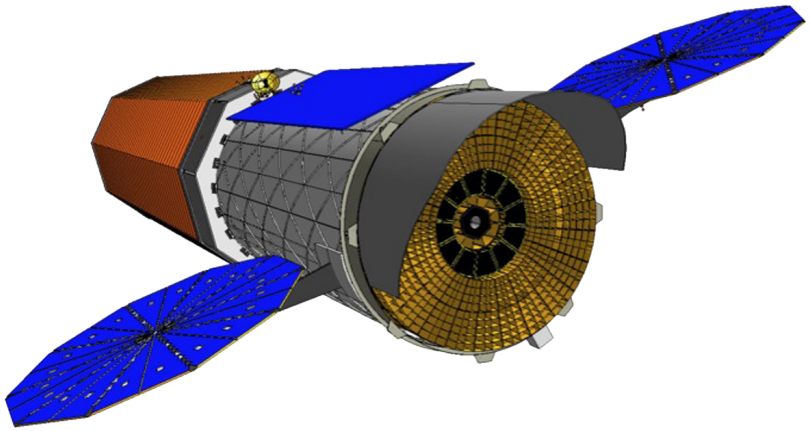
The International X-Ray Observatory

- What happens close to a black hole?
- When and how did super-massive black holes grow?
- How does large scale structure evolve?
- What is the connection between these processes?

Decadal Survey key points

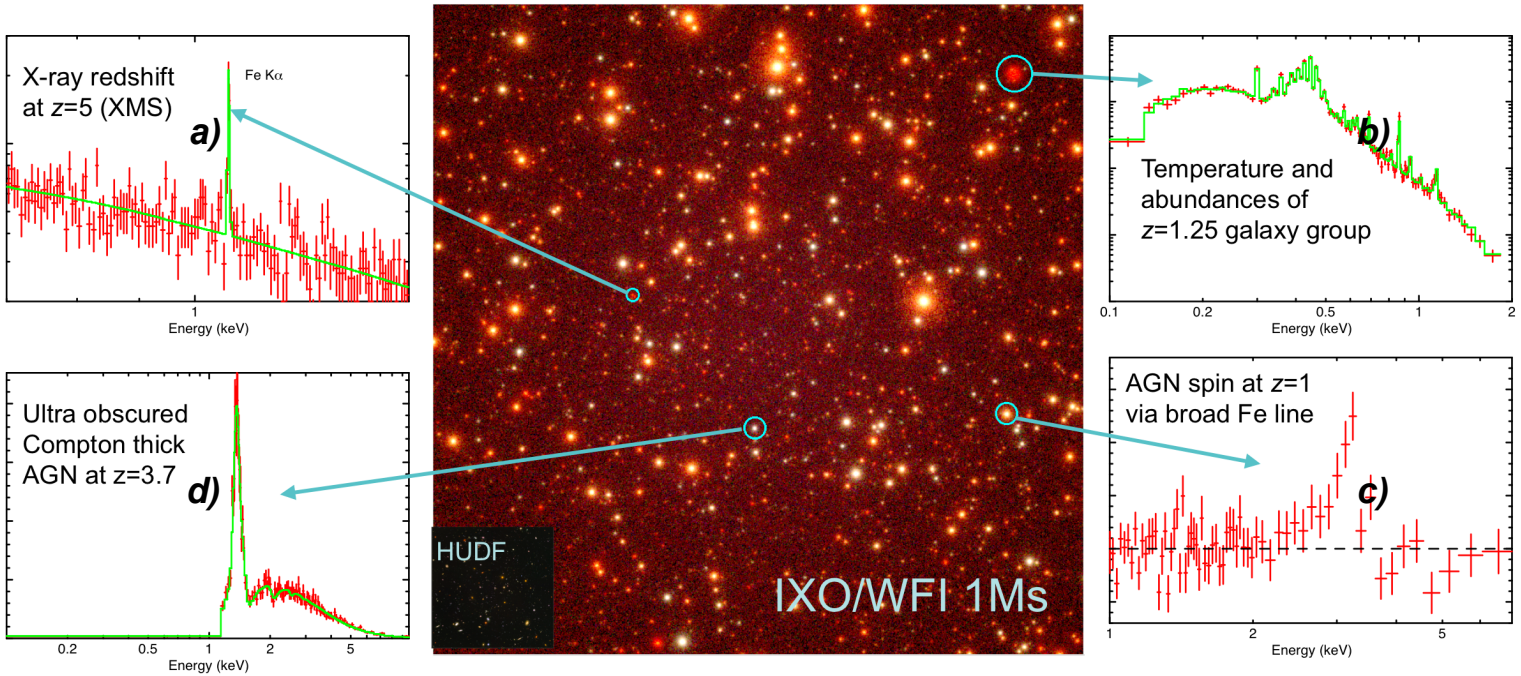


Hydra A Galaxy Cluster



- 20m focal length
- Mass 5900 kg (incl. system margin)
- NASA EELV or ESA Ariane V
- L2 orbit
- 5 year lifetime; 10 year consumables

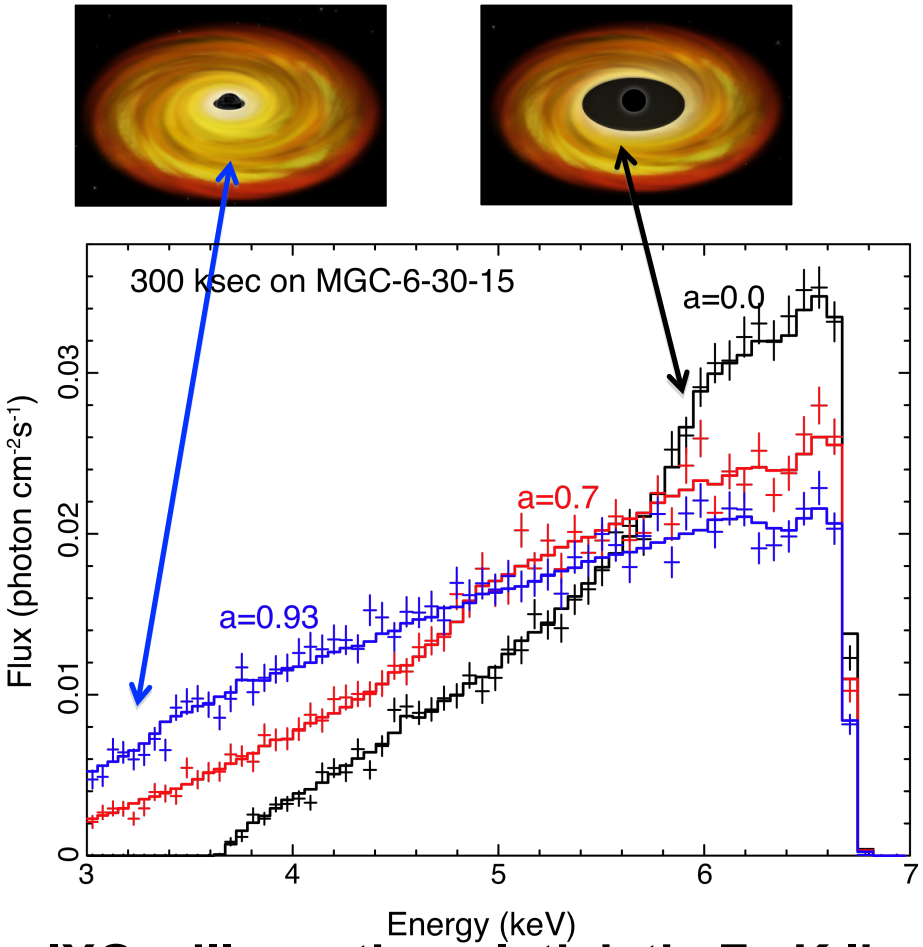
Black Hole & Large Scale Structure Evolution

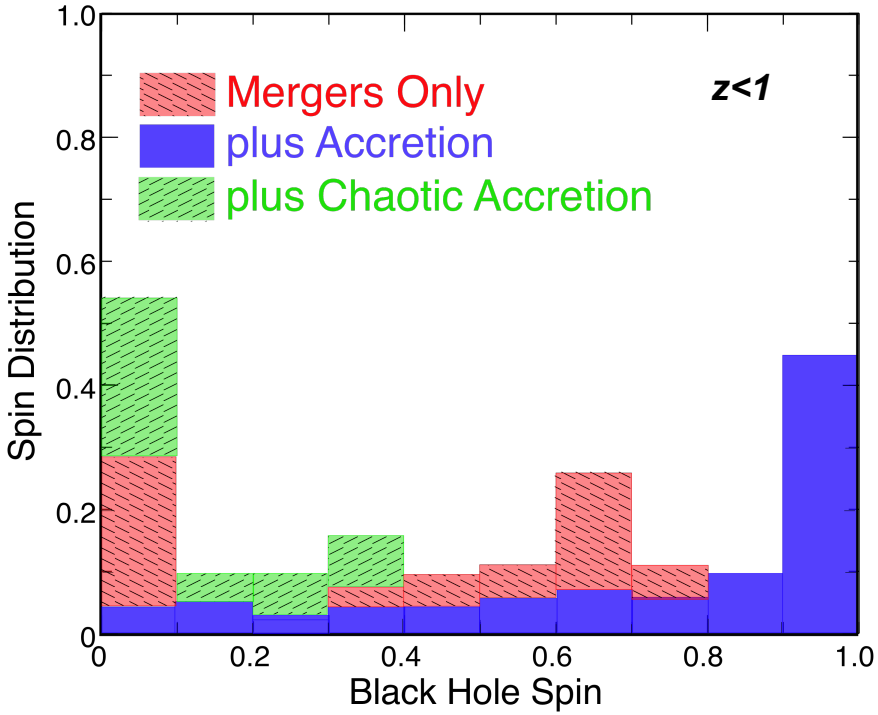


IXO has the ability to characterize the extragalactic Universe:

- ***a) determine redshift autonomously in the X-ray band***
- ***b) determine temperatures and abundances even for low luminosity galaxy groups***
- ***c) make spin measurements of AGN to a similar redshift***
- ***d) uncover the most heavily obscured, Compton-thick AGN***

Super-massive Black Hole Spin & Growth





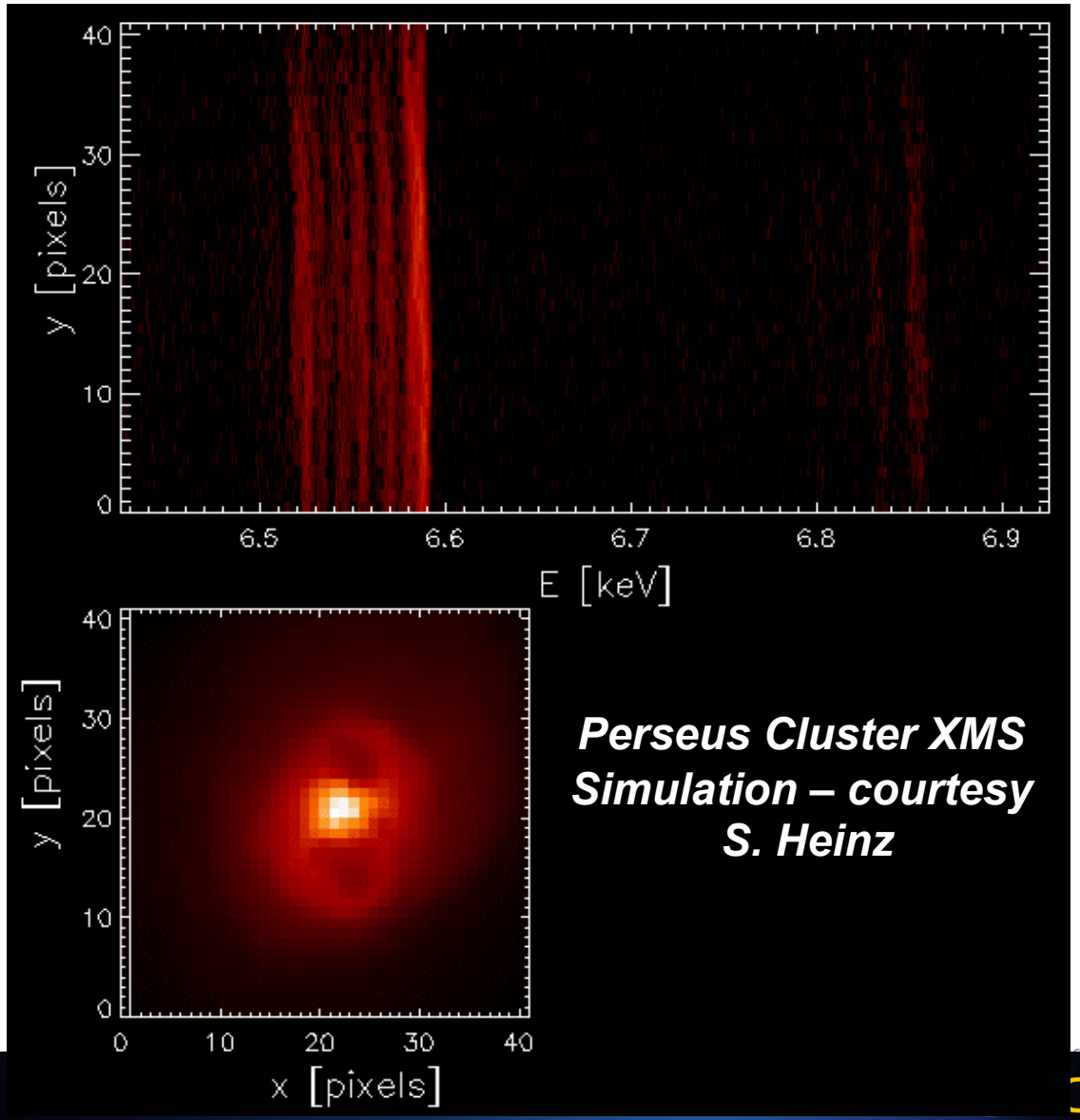
Based on Berti & Volonteri (2008)

IXO will use the relativistic Fe K line to determine the black hole spin for 300 AGN within z < 0.2 to constrain the SMBH merger history

Cosmic Feedback

- *AGN jets create bubbles of hot gas in clusters in feedback process that regulates the growth of galaxies and clusters of galaxies*

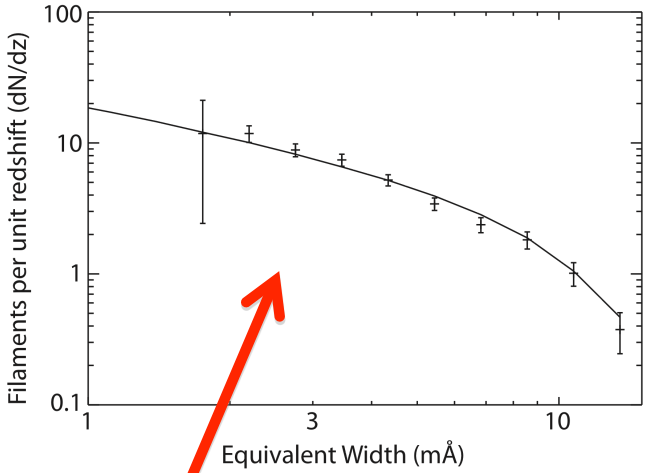
- *Velocity measurements of the bubble walls are crucial to determine the heating and state of hot gas found within clusters of galaxies*

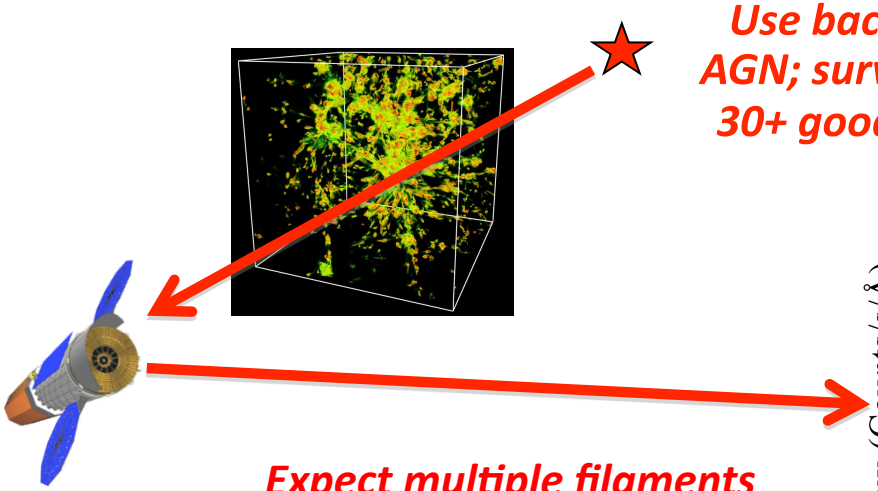


Perseus Cluster XMS Simulation – courtesy S. Heinz

Find and Characterize the Missing Baryons

- Where is the hot gas relative to the galaxies?
- How do filaments connect to groups and clusters?

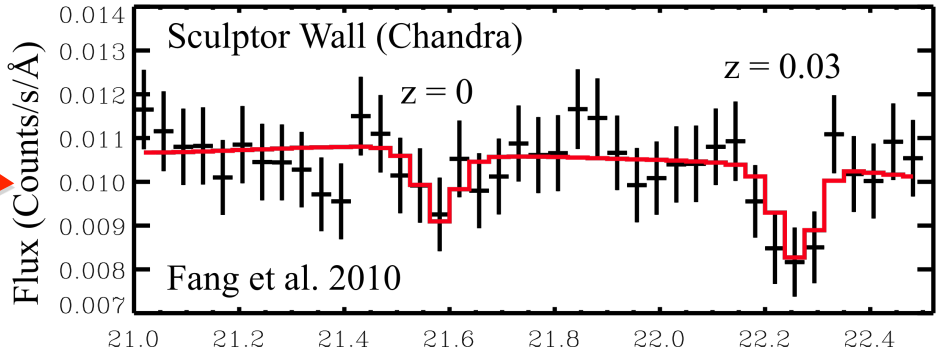




Use background AGN; surveys show 30+ good sources.

Compare distribution of filaments to models

Expect multiple filaments in each line of sight

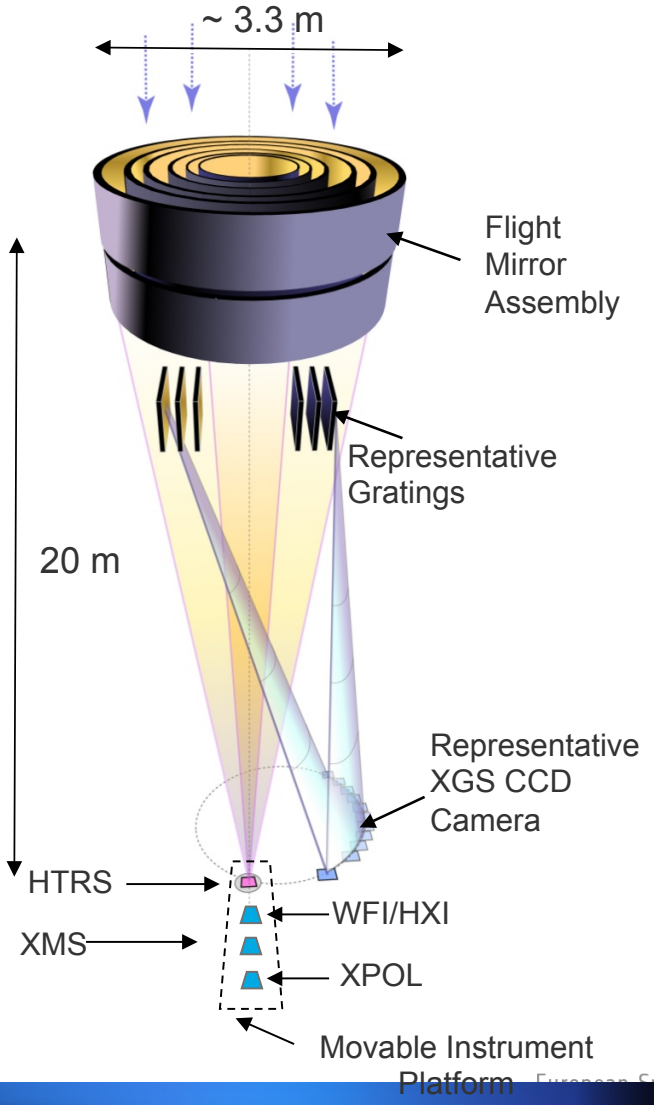


Mission Payload

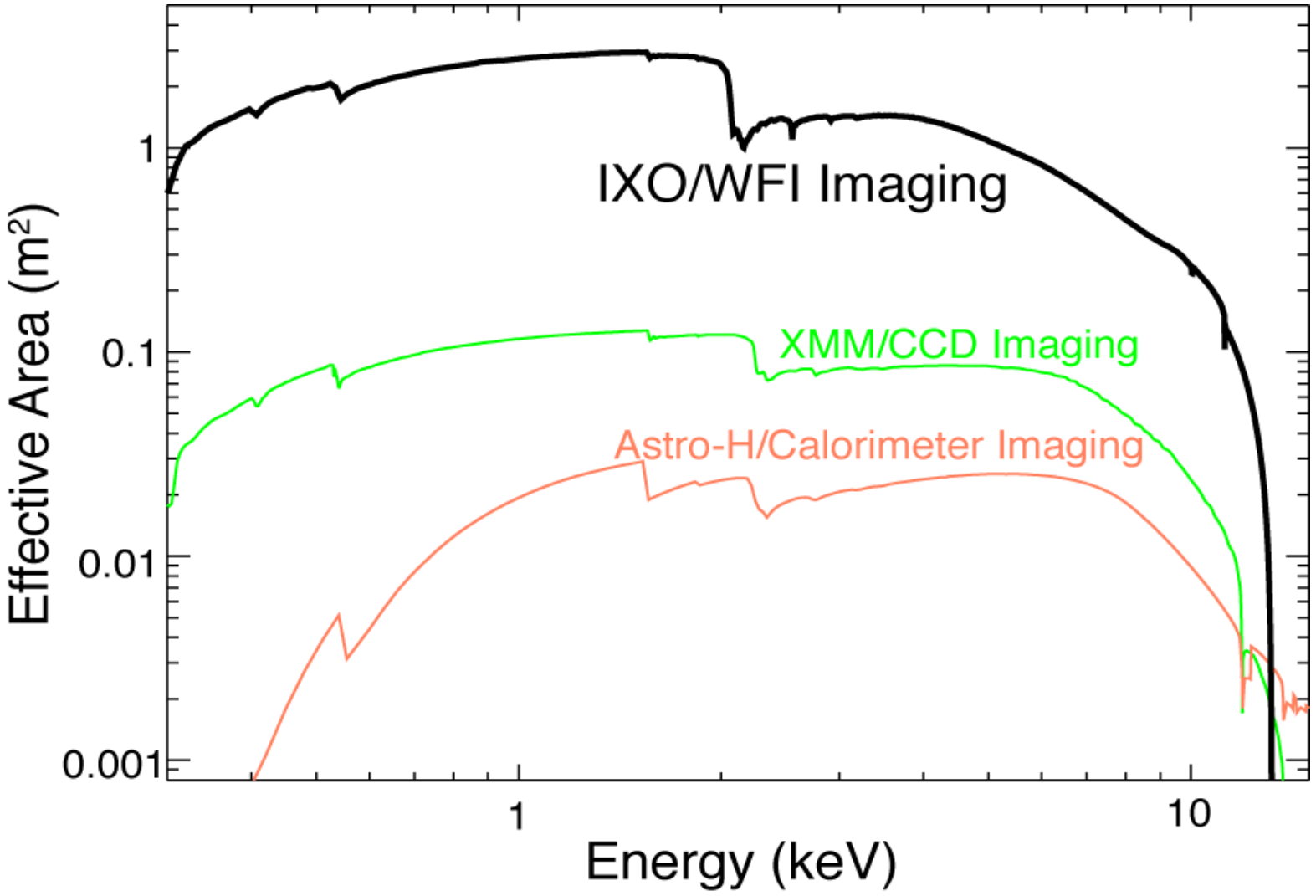
- **Flight Mirror Assembly (FMA)**
  - **Highly nested grazing incidence optics**
  - **Segmented glass or silicon pore optics technology approach**

- **Instruments**
  - **Wide Field & Hard X-ray Imager (WFI/HXI)**
  - **X-ray Microcalorimeter Spectrometer (XMS)**
  - **X-ray Grating Spectrometer (XGS)**
  - **X-ray Polarimeter (X-POL)**
  - **High Time Resolution Spectrometer (HTRS)**

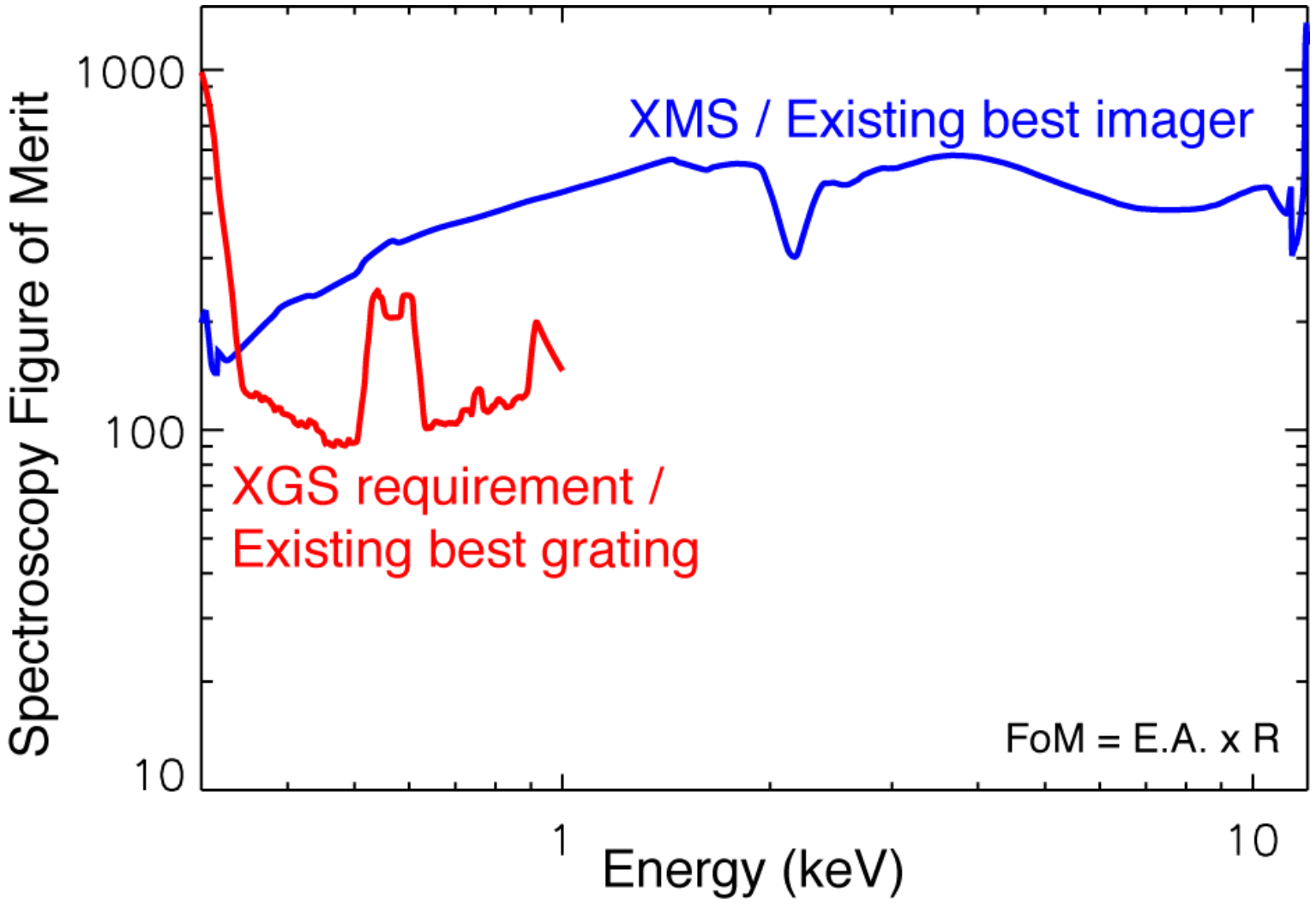
- **XMS, WFI/HXI, X-POL and HTRS observe one at a time by being inserted into focal plane via a Movable Instrument Platform**



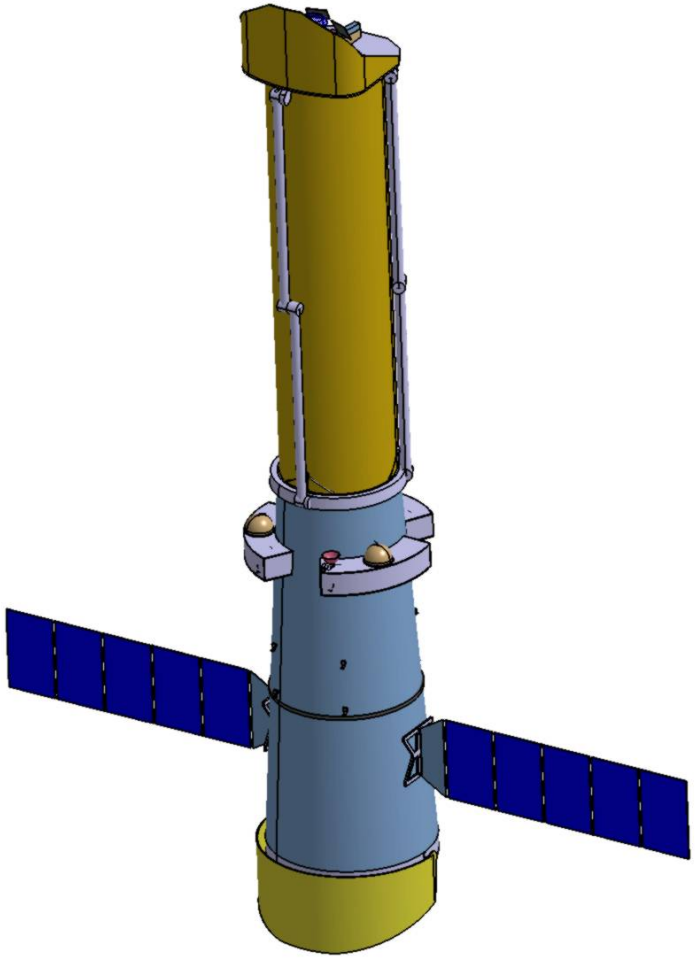
Effective Area Increase



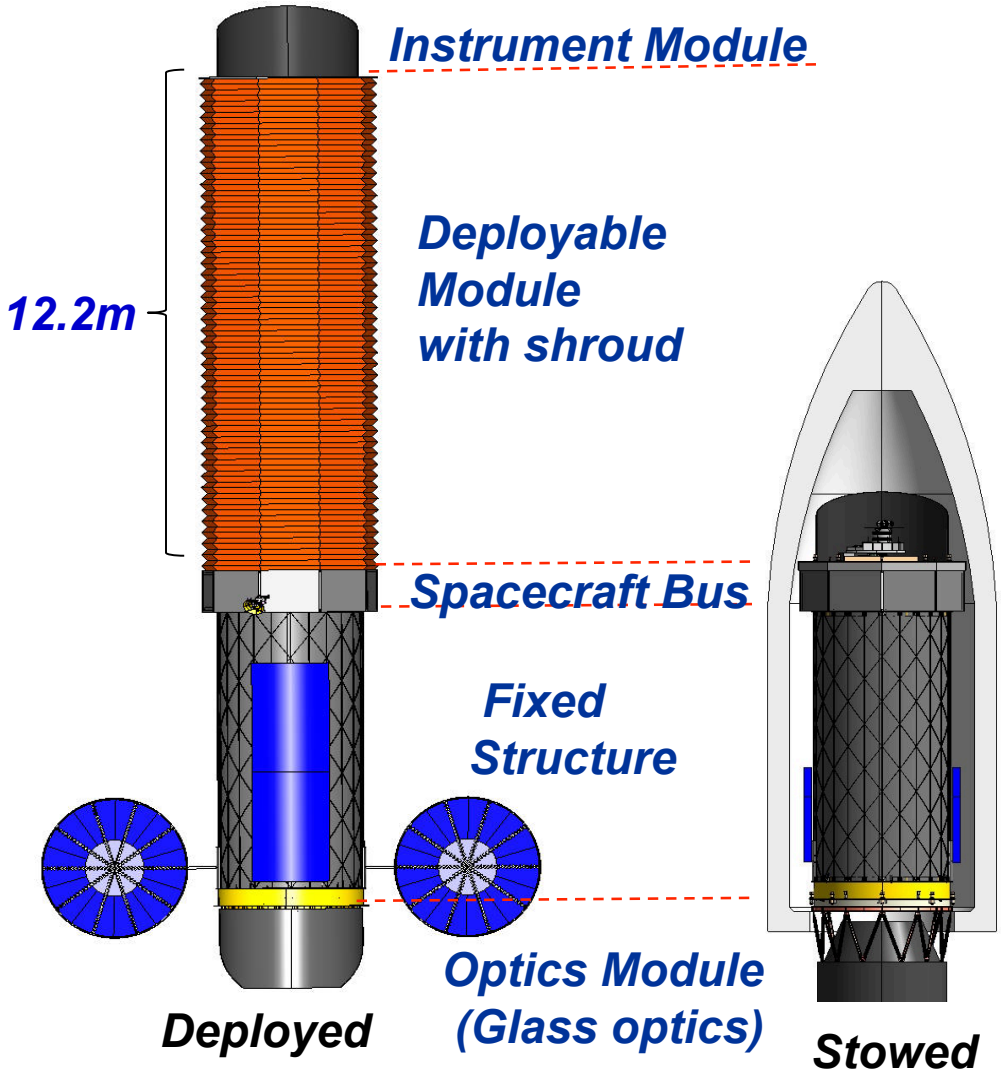
(Effective Area * Resolution) Figure of Merit Ratio



IXO Mission Concepts

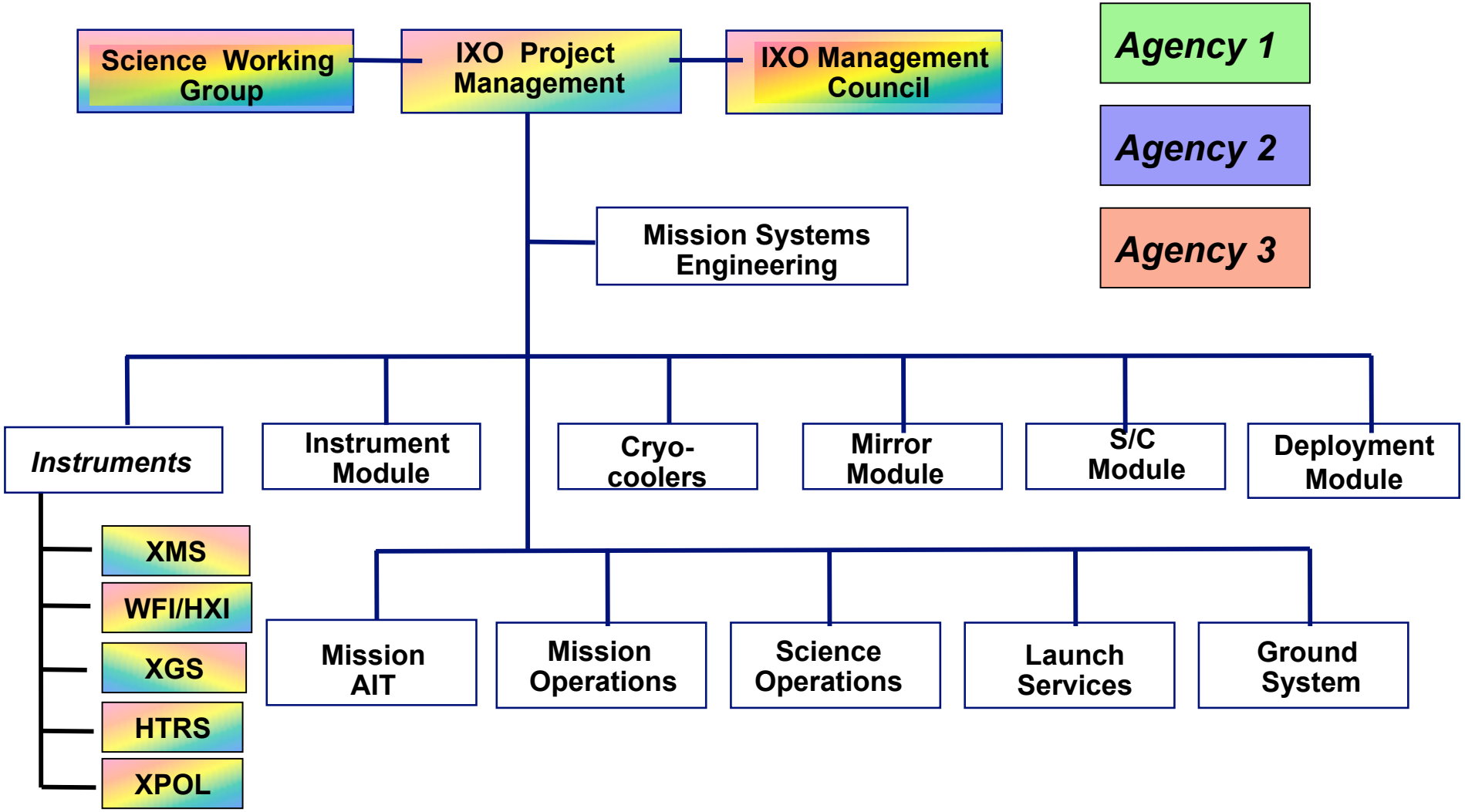


Deployed ESA Configuration



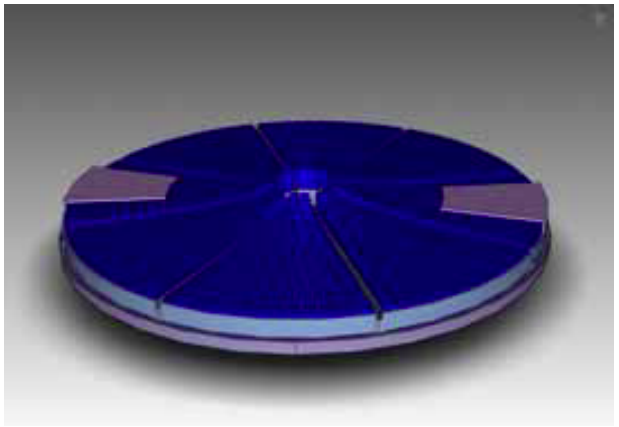
NASA Configuration

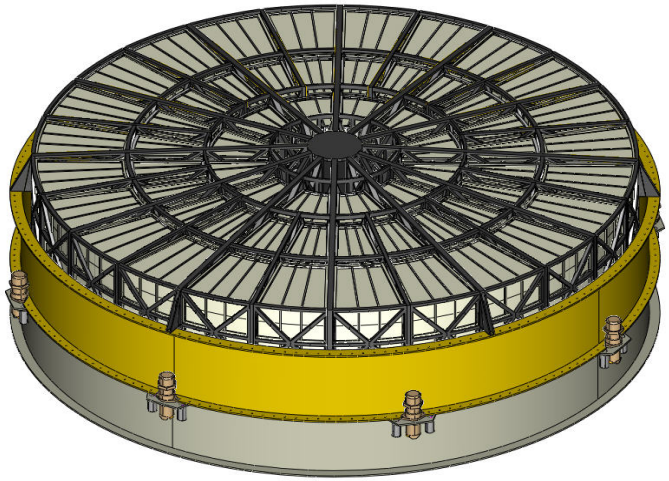
Agency Responsibilities

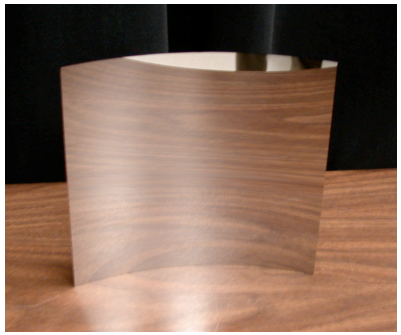


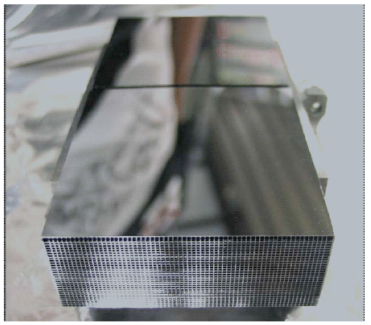
IXO Flight Mirror Assembly

- **Key requirements:**
  - **Effective area ~3 m^2 @ 1.25 keV**
  - **Angular Resolution <= 5 arc sec**
- **Two parallel technology approaches being pursued:**
  - **NASA: Segmented glass**
  - **ESA: Silicon micro-pore**
- **Both making progress**



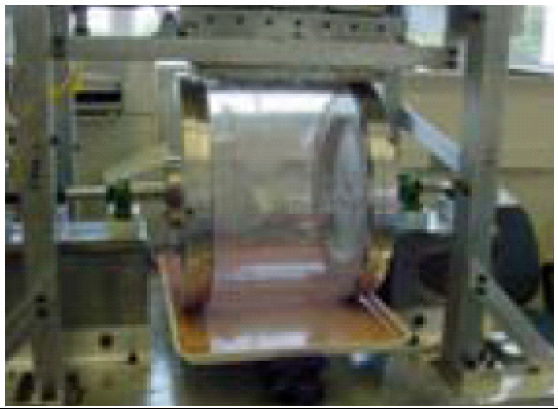




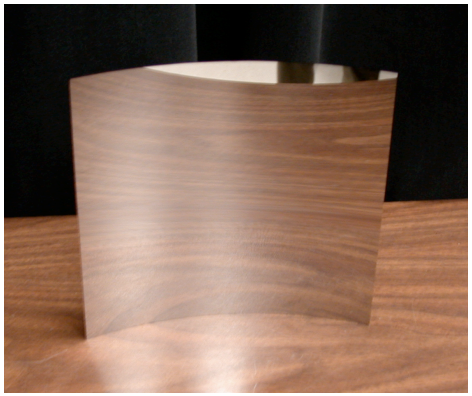


Glass Segment Progress

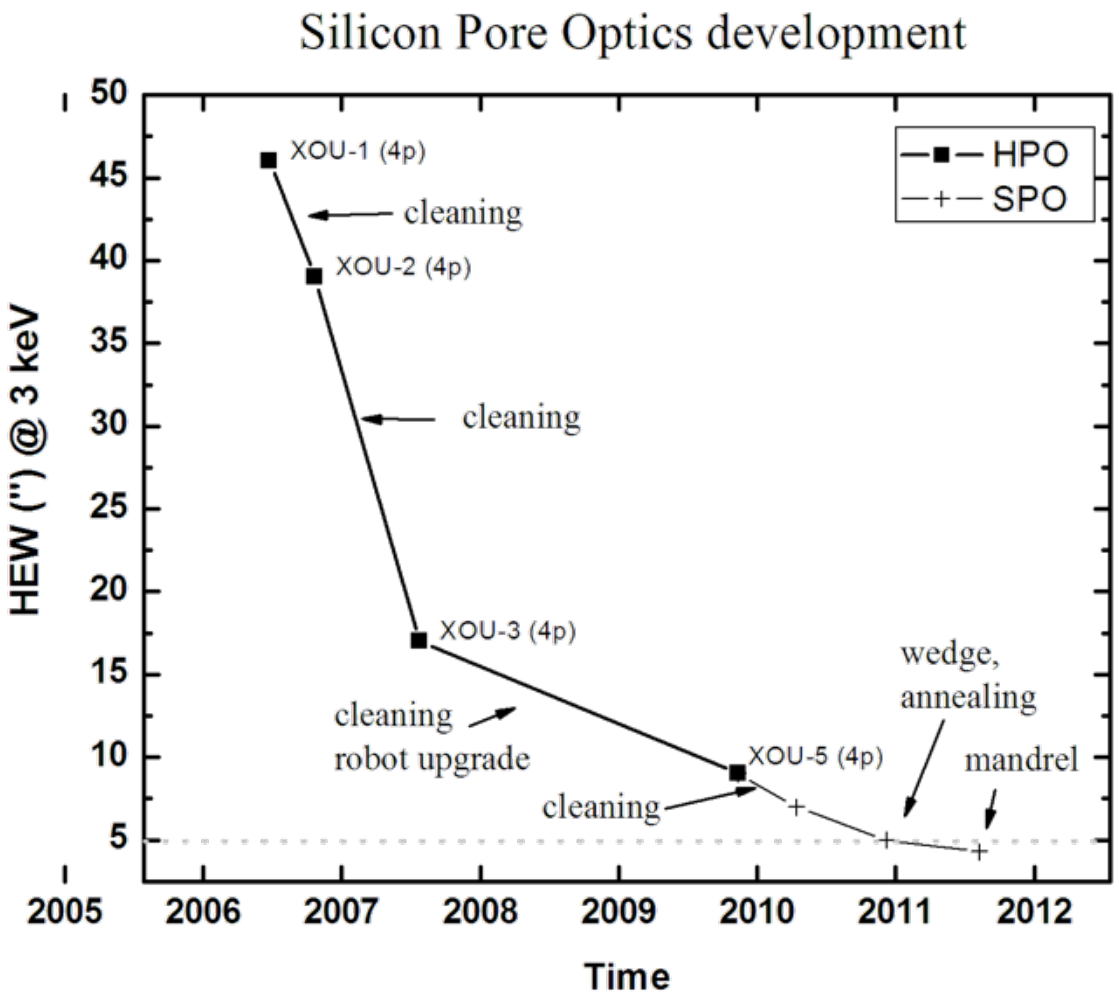
Date	HPD (two reflections	Comment
November 2007	~16”	**Progress in reducing mid-frequency errors - using normal incidence metrology** **Metrology validated by X-ray testing**
April 2009	~14.7”	
August 2009	~12”	
October 2009	~10”	
December 2009	~8.5”	
January 2010	~7.5”	
Transitioning from existing mandrels (~6.5”) to new mandrels (~2.4”)		

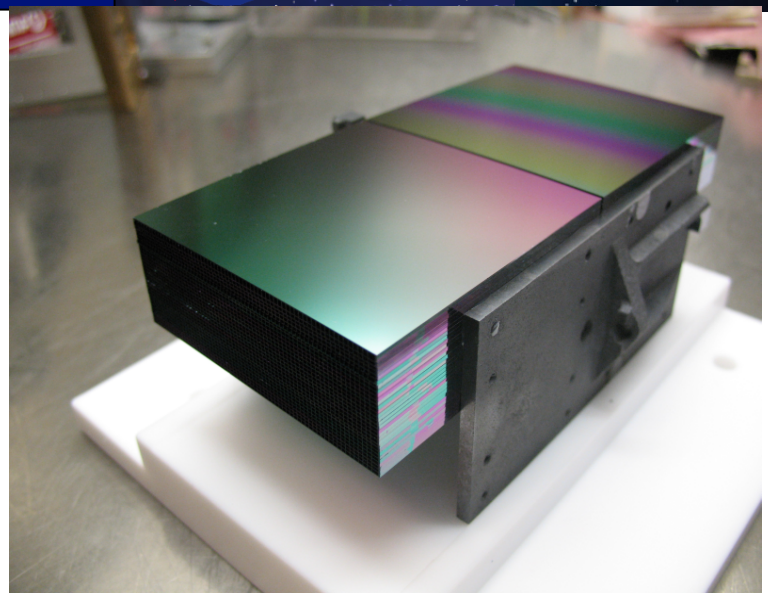


IXO Requirement: 4 arcsec HPD



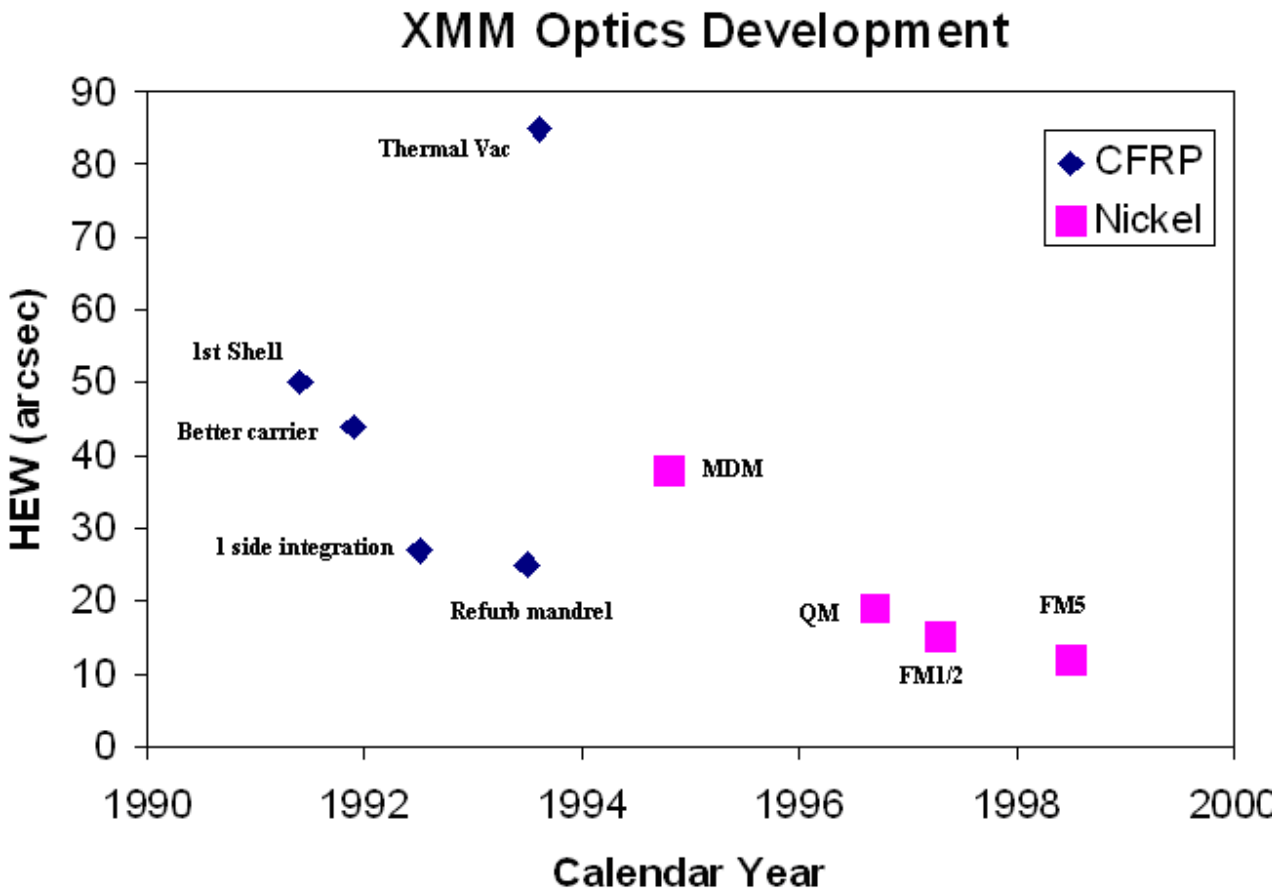
SPO Development status





We've done it before!

- **AXAF TMA 15% Encircled Energy in 1 arcsec dia. (dust and control of surface errors in different freq ranges) - 1985**
- **VETA 80% in 1 arcsec on a H/P pair - 1993**
- **CHANDRA HRMA achieved ~75% EE in 1 arcsecond diameter**



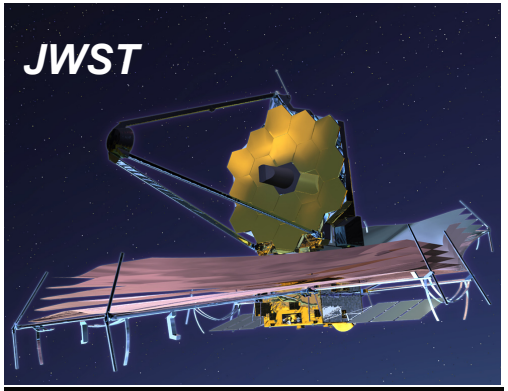
Within Budget / On –time !

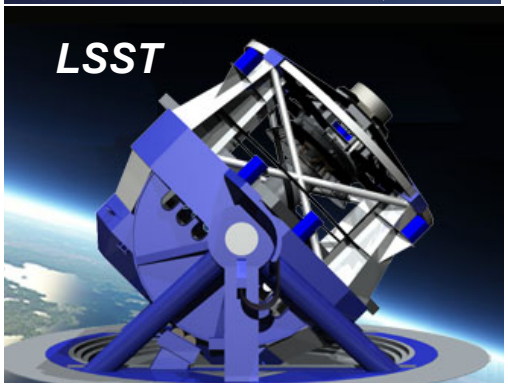
- XMM-Newton cost to ESA was ~550M AU and actually within the allocated budget
- AXAF life cycle cost following the restructuring process to AXAF-I/S in 1992 was $3.7Bn, (cf. original *serviced AXAF* $5.7Bn)

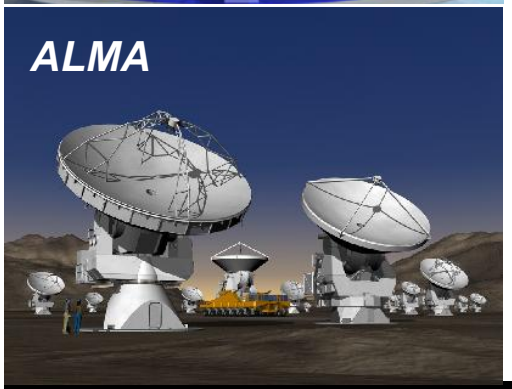
- XMM launch date envisaged at AO and long before proceeding to implementation phase was late 1997 (2yrs slip in 12 years)
- After AXAF restructuring in 1992, planned launch date was Q3 1998 (1yr slip in 8 years)

- The X-ray astronomy community has a great track record in delivering hardware within budget and on-time !!

IXO: The next great X-ray observatory



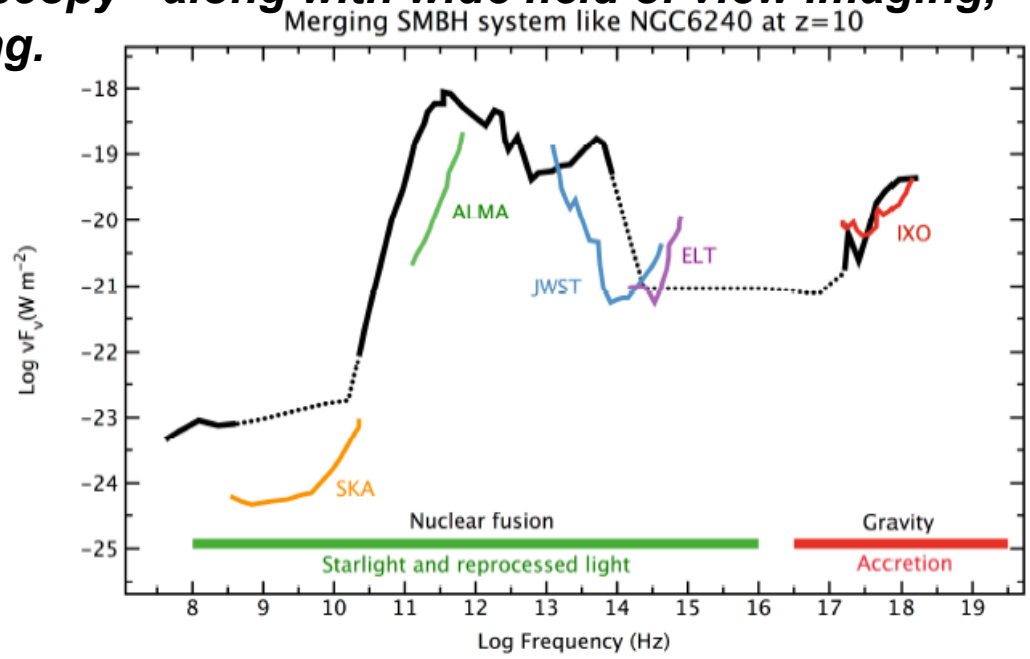




X-ray astronomy has 40-year history of international collaboration from conception through operations as demonstrated by ongoing X-ray missions Chandra, XMM-Newton, Suzaku, Fermi, INTEGRAL and Swift.

IXO will be a Facility-class Observatory, building on the 3000+ general observer community of Chandra and XMM-Newton

The future IXO mission will bring a factor of 10 gain in telescope aperture and a factor of 100 increase in throughput for high resolution spectroscopy - along with wide field of view imaging, polarimetry & timing.



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